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CERTIFICATION

I, Takao Kohno; 4-3, Tsuriganecho 2-chome, Chuo-ku, Osaka 540, Japan, hereby certify that I am the translator of the documents in respect of an application for a patent filed in Japan on the 8th day of December, 2000 (2000-375173)

and certify that the following is a true and correct translation to the best of my knowledge and belief.

KOHNO PATENT OFFICE

KOHNO Takao

Dated this 16th day of May, 2003

[Name of the Document] Specification

[Title of the Invention] Electric Power Steering Apparatus

[Claim for Patent]

[Claim 1]

An electric power steering apparatus comprising: a steering assist motor for assisting operation of a steering mechanism by steering of steering means; and a supporting unit for supporting said motor on a stationary member, characterized in that the supporting unit has releasing means for releasing the support by impact energy applied to the motor.

[Claim 2]

The electric power steering apparatus according to Claim 1, wherein the supporting unit comprises a projection provided at one of the motor and the stationary member and a recess provided at the other of the motor and the stationary member, the projection being inserted into the recess, and the releasing means comprises a movement permitting portion for permitting relative movement of the projection in the recess and a slip-off portion from where the projection slips off the movement permitting portion.

[Claim 3]

The electric power steering apparatus according to Claim 2, wherein the releasing means has an elastic member for pushing the projection or the recess portion provided at the motor outward at a position of the slip-off portion.

[Claim 4]

The electric power steering apparatus according to Claim 2 or 3, wherein the projection is configured as an external thread and the recess is configured as a through bore.

[Claim 5]

The electric power steering apparatus according to one of Claims 1 through 4, wherein the motor has a rotor arranged so that a rotational center thereof intersects an axis of a steering shaft joined to the steering means and a cylindrical motor housing for supporting said rotor, and a peripheral face of said motor housing is provided with an impact energy receiver for applying rotational force to the motor housing by the impact stress.

[Claim 6]

An electric power steering apparatus comprising: a steering shaft joined to steering means; a shaft housing for accommodating said steering shaft; a steering assist motor for assisting operation of a steering mechanism joined to the steering shaft, the steering assist motor having a rotor arranged so that a rotational center thereof intersects an axis of the steering shaft and a cylindrical motor housing for supporting said rotor; and a supporting unit for supporting one end portion of the motor housing on the shaft housing, characterized in that the supporting unit comprises: a plurality of projections provided at peripheral positions of the motor housing; an arc-shaped groove provided at the shaft housing, into which the projections are inserted so as to be movable in a longitudinal direction thereof; and a slip-off portion from where the projections slip off the arc-shaped groove when the projections move.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Application]

The present invention relates to an electric power steering apparatus using a motor as a generation source of steering assistance force.

[0002]

[Prior Art]

FIG. 10 is a front view showing a constitution of a conventional electric power steering apparatus.

As shown in FIG. 10, for example, an electric power steering apparatus for a vehicle comprises a steering shaft 101 joined to a steering wheel 100 for steering; a shaft housing 102 for accommodating said steering shaft 101; a steering assist motor 104 for assisting operation of a steering mechanism joined via a joint to the steering shaft 101, the steering assist motor 104 having a rotor arranged so that a rotational center thereof intersects an axis of the steering shaft 101 and a cylindrical motor housing 103 for supporting said rotor; fastening members 105 for supporting one end portion of the motor housing 103 on a lower end portion of the shaft housing 102; a lower mounting member 106 for mounting a lower end portion of the shaft housing 102 to a car body 109 (see FIG. 11); and an upper mounting member 108 for mounting an axially middle portion of the shaft housing 102 to the car body 109 (see FIG. 11), the upper mounting member 108 having an impact energy absorber 107 for absorbing impact energy of a secondary crash.

[0003]

The steering shaft 101 is divided into an upper shaft 101a joined to the steering wheel 100 and a lower shaft 101b joined to the joint, the divided end portions being connected to each other by an impact energy absorber for absorbing impact energy of a secondary crash. The shaft housing 102 is divided into an upper shaft housing 102a to which the upper mounting member 108 is mounted and a lower shaft housing 102b to which the motor 104 and the

lower mounting member 106 are mounted, the divided end portions being engaged with each other so as to be movable relatively.

[0004]

FIG. 11 is a schematic representation showing a state of a conventional electric power steering apparatus mounted to a car body.

The electric power steering apparatus constituted as above is disposed in a passenger's room. As shown in FIG. 11, the lower mounting member 106 and the upper mounting member 108 are mounted to the car body 109. The joint 110, which connects the steering shaft 101 and the steering mechanism of the electric power steering apparatus mounted to the car body 109, is disposed through an instrument panel 111 of the car body 109.

[0005]

The instrument panel 111 of the car body 109 is occasionally transformed toward the interior of the passenger's room by a crash (a primary crash), such as a frontal crash, of a vehicle. When a driver crashes (a secondary crash) into the steering wheel 100 by the action of a shock of a primary crash and impact energy thereof is applied to the upper steering shaft 101a, and further to the upper shaft housing 102a from said upper steering shaft 101a, the upper steering shaft 101a and the upper shaft housing 102a are pressured in an axial direction, the impact energy absorber of the steering shaft 101 and the impact energy absorber 107 of the upper mounting member 108 are destroyed, and the upper steering shaft 101a and the upper shaft housing 102a move relatively with the lower steering shaft 101b and the lower shaft housing 102b, so that the impact energy of the secondary crash can be absorbed.

[0006]

[Problems to Be Solved by the Invention]

However, the steering assist motor 104 of the electric power steering apparatus which is constituted as the above projects outward in a radial direction of the shaft housing 102 on a relatively large scale. Moreover, said motor 104 is fixed to the lower shaft housing 102 with fastening members 105. At the time of the secondary crash, a driver's leg occasionally strikes against the motor 104 since the upper shaft housing 102a moves relatively with the lower shaft housing 102b to which the motor 104 is mounted. This may cause a problem that driver's damage becomes serious. Moreover, when the instrument panel 111 or the like of the car body 109 strikes against the motor 104 at the time of the primary crash, transformation of the instrument panel 111 or the like is hindered by the motor 104, thereby preventing absorption of impact energy.

[0007]

The present invention has been made with the aim of solving the above problems, and one object of the invention is to provide an electric power steering apparatus in which a supporting unit for supporting a steering assist motor on a stationary member has releasing means for releasing the support by impact energy applied to the motor, with which support of the motor can be automatically released when impact energy is applied to the motor.

[0008]

Another object of the present invention is to provide an electric power steering apparatus in which the supporting unit comprises a projection and a recess into which said projection is inserted and the releasing means comprises a movement permitting portion for permitting relative movement of the

projection in the recess and a slip-off portion from where the projection slips off said movement permitting portion, with which the projection can move from the recess to the movement permitting portion, and further outward from the slip-off portion, when impact energy is applied to the motor, thereby releasing support of the motor on the stationary member preferably.

[0009]

Another object of the present invention is to provide an electric power steering apparatus in which the releasing means has an elastic body for pushing the projection or the recess portion outward at the position of the slip-off portion, with which the projection or the recess portion is pushed outward by the elastic body.

[0010]

A further object of the present invention is to provide an electric power steering apparatus in which the projection is configured as an external thread and the recess is configured as a through bore, with which the motor can be supported in a manner that the support can be released, utilizing an existing motor supporting structure having fastening members.

[0011]

Another object of the present invention is to provide an electric power steering apparatus in which an impact energy receiver for applying rotational force to the motor housing by the impact energy is provided at a peripheral face of a cylindrical motor housing which is arranged to intersect an axis of a steering shaft, with which impact energy can be suitably applied to the impact energy receiver and the motor housing can be rotated preferably.

[0012]

A further object of the present invention is to provide an electric power steering apparatus in which a supporting unit for supporting a cylindrical motor housing on a shaft housing comprises a plurality of projections provided at peripheral positions of the motor housing; an arc-shaped groove provided at the shaft housing, into which groove the projections are inserted so as to be movable in a longitudinal direction thereof; and a slip-off portion from where the projections slip off the arc-shaped groove when the projections move, with which the projections can move from the recess to the movement permitting portion, and further outward from the slip-off portion, when impact energy is applied to the motor, thereby automatically releasing support of the motor on the stationary member.

[0013]

[Means for Solving the Problems]

An electric power steering apparatus according to the first invention comprises a steering assist motor for assisting operation of a steering mechanism by steering of steering means and a supporting unit for supporting said motor on a stationary member, and is characterized in that the supporting unit has releasing means for releasing the support by impact energy applied to the motor.

[0014]

With this first invention constructed so that the support of the steering assist motor is released by impact energy applied to the motor, when impact energy of a primary crash and/or a secondary crash is applied to the motor, support of the motor on the stationary member can be automatically released.

[0015]

An electric power steering apparatus according to the second invention is characterized in that the supporting unit comprises a projection provided at one of the motor and the stationary member and a recess provided at the other of the motor and the stationary member, the projection being inserted into the recess, and the releasing means comprises a movement permitting portion for permitting relative movement of the projection in the recess and a slip-off portion from where the projection slips off the movement permitting portion.

[0016]

With this second invention, the motor can be supported on the stationary member by inserting the projection into the recess. In this supporting state, the projection provided at the motor or at the stationary member moves from the recess to the movement permitting portion, and further outward from the slip-off portion, when impact energy of a primary crash and/or a secondary crash is applied to the motor. Support of the motor on the stationary member can thus be released preferably.

[0017]

An electric power steering apparatus according to the third invention is characterized in that the releasing means has an elastic body for pushing the projection or the recess portion, which is provided at the motor, outward at the position of the slip-off portion.

[0018]

With this third invention, when the projection provided at the motor or at the stationary member moves from the recess along the movement permitting portion to the position of the slip-off portion, the elastic body pushes the projection or the recess portion outward.

[0019]

An electric power steering apparatus according to the fourth invention is characterized in that the projection is configured as an external thread and the recess is configured as a through bore.

[0020]

With this fourth invention, the motor can be supported in a manner that the support can be released, utilizing an existing motor supporting structure having fastening members.

[0021]

An electric power steering apparatus according to the fifth invention is characterized in that the motor has a rotor arranged so that a rotational center thereof intersects an axis of the steering shaft joined to the steering means and a cylindrical motor housing for supporting said rotor, and a peripheral face of the motor housing is provided with an impact energy receiver for applying rotational force to the motor housing by the impact energy.

[0022]

With this fifth invention wherein the peripheral face of the cylindrical motor housing of the motor arranged so as to intersect the axis of the steering shaft is provided with an impact energy receiver, impact energy of a primary crash and/or a secondary crash can be suitably applied to the impact energy receiver, so that the motor housing can be rotated preferably.

[0023]

An electric power steering apparatus according to the sixth invention comprises a steering shaft joined to steering means; a shaft housing for accommodating said steering shaft; a steering assist motor for assisting

operation of a steering mechanism joined to the steering shaft, the steering assist motor having a rotor arranged so that a rotational center thereof intersects an axis of the steering shaft and a cylindrical motor housing for supporting said rotor; and a supporting unit for supporting one end portion of the motor housing on the shaft housing, and is characterized in that the supporting unit comprises a plurality of projections provided at peripheral positions of the motor housing; an arc-shaped groove provided at the shaft housing, into which groove the projections are inserted so as to be movable in a longitudinal direction thereof; and a slip-off portion from where the projections slip off the arc-shaped groove when the projections move.

[0024]

With this sixth invention, the motor can be supported on the shaft housing by inserting the projections provided at the peripheral positions of the cylindrical motor housing of the motor arranged so as to intersect the axis of the steering shaft into the arc-shaped groove. In this supporting state, projections provided at the motor housing can move in the arc-shaped groove, and further outward from the slip-off portion, when impact energy of a primary crash and/or a secondary crash is applied to the motor housing. Support of the motor housing on the shaft housing can thus be automatically released.

[0025]

[Embodiment of the Invention]

The following description will explain the present invention in detail with reference to the drawings illustrating some embodiments thereof.

Embodiment 1

FIG. 1 is a front view showing a constitution of an electric power

steering apparatus according to the present invention, and FIG. 2 is a sectional view showing a constitution of the electric power steering apparatus.

[0026]

As shown in FIG. 1 and FIG. 2, the electric power steering apparatus comprises a steering shaft 2 joined to a steering wheel 1 for steering; a shaft housing 3 for supporting and accommodating said steering shaft 2; a torque sensor 4 for detecting steering torque applied to the steering wheel 1; a steering assist motor 5 driven based on a result of the detection of the torque sensor 4, the steering assist motor 5 having a rotor arranged so that a rotational center thereof intersects an axis of the steering shaft 2 and a cylindrical motor housing 51 for supporting said rotor; a supporting unit 6 for supporting one end portion of the motor housing 51 on a lower end portion of the shaft housing 3; a lower mounting member 7 for mounting a lower end portion of the shaft housing 3 to a car body; and an upper mounting member 8 for mounting an axially middle portion of the shaft housing 3 to the car body, the upper mounting member 8 having an impact energy absorber 81 for absorbing impact energy of a secondary crash. The apparatus is constituted so that operation of a steering mechanism joined via a joint 9 to a lower end of the steering shaft 2 is assisted by rotation of the motor 5, thereby reducing driver's load for steering.

[0027]

The steering shaft 2 comprises a first shaft 21 joined to the steering wheel 1; a second shaft 22 connected to a lower end portion of the first shaft 21 via an impact energy absorber 24 made of synthetic resin for absorbing impact energy applied to the steering wheel 1 by a driver; and a third shaft 23 connected to a lower end portion of said second shaft 22 via a torsion bar 25.

Said third shaft 23 is joined via a reduction gear mechanism 10 to the rotor of the motor 5. A lower end of the third shaft 23 is joined via a joint 9 to a steering mechanism. The torque sensor 4 is adapted to detect steering torque by relative rotational displacement of the second shaft 22 and the third shaft 23.

[0028]

The shaft housing 3 comprises a cylindrical first shaft housing 31 for supporting and accommodating the first shaft 21; a cylindrical second shaft housing 32 for accommodating the second shaft 22, the second shaft housing 32 being engaged into a lower end portion of the first shaft housing 31 so as to be movable relatively; and a third shaft housing 33 having a first receiver 33a for accommodating the torque sensor 4 and a driven gear 10a of the reduction gear mechanism 10, the third shaft housing 33 being fitted to a lower end portion of the second shaft housing 32. The lower mounting member 7 is mounted at a lower end of said third shaft housing 33.

[0029]

FIG. 3 is a partly sectional plan view of a motor portion.

The third shaft housing 33 is provided with a substantially cylinder-shaped second receiver 33b, which is coupled to one side of the first receiver 33a, for accommodating a driving gear 10b of the reduction gear mechanism 10 and a ring-shaped motor supporting portion 34, which is provided at one end side of said second receiver 33b, for supporting the motor housing 51.

[0030]

At the motor supporting portion 34 the motor housing 51 is supported by the supporting unit 6 so as to be angularly rotatable. The motor 5 is

arranged to intersect an axis of the steering shaft 2, supported by the motor housing 51. In this arrangement of the motor 5, said motor 5 projects outward in a radial direction of the shaft housing 3 on a relatively large scale. Consequently, the motor 5 suitably strikes against an instrument panel or the like of a car body at the time of a primary crash and the motor 5 suitably strikes against a driver's leg at the time of a secondary crash.

[0031]

FIG. 4 is a sectional view taken along the line IV-IV of FIG. 3.

A peripheral face of the motor housing 51 of the motor 5 is provided with upper and lower impact energy receivers 52 and 53 for applying rotational force to said motor housing 51 when impact energy of a primary crash and/or a secondary crash is applied to the motor 5, particularly to the motor housing 51.

[0032]

Said impact energy receivers 52 and 53 are formed by arranging a plurality of ribs at diagonal positions with regard to a rotational center of the rotor 54 on faces, which are supposed to be upper and lower faces of the motor 5 when the electric power steering apparatus is mounted to the car body. Though the impact energy receivers 52 and 53 are formed to cover the total length of the motor housing 51, the impact energy receivers 52 and 53 may be formed only at a part in an axial direction of the motor housing 51, and moreover, may be configured so that a plurality of rib portions are provided throughout the motor housing 51.

[0033]

The supporting unit 6 comprises a plurality of tongues 11a configured as projections 11 provided at peripheral positions of the motor housing 51; a

plurality of arc-shaped grooves 12a configured as recesses 12 which are provided in an arc shape within the motor supporting portion 34 and into which the tongues 11a are inserted so as to be movable in a longitudinal direction thereof; and slip-off portions 13 from where said tongues 11a slip off the arc-shaped grooves 12a when the tongues 11a move with angular rotation of the motor housing 51.

[0034]

Two tongues 11a are provided at a peripheral face of one end portion of the motor housing 51 with equal phase difference. It should be noted that more than two tongues 11a may be provided.

[0035]

An arc-shaped groove 12a is formed to cover an angle of approximately 45° coaxially with the motor supporting portion 34. One longitudinally end portion of the arc-shaped groove 12a constitutes a supporting unit 6 for supporting the motor 5 in engagement with a tongue 11a. The other end side excepting the supporting unit 6 constitutes a movement permitting portion 12b for permitting relative movement of the tongue 11a. The movement permitting portion 12b and the slip-off portion 13 provided at the other longitudinally end portion of the arc-shaped groove 12a constitute releasing means for releasing support of the motor 5 by impact energy applied to the motor 5.

[0036]

Within the arc-shaped groove 12a, a thin arc-shaped contact plate 14 made of a material with relatively low frictional resistance, such as synthetic resin, and an elastic body 15 consisting of a coiled spring for pushing said

contact plate 14 against one face of the tongue 11a are provided. Said elastic body 15 prevents the tongue 11a from trembling in the arc-shaped groove 12a. The contact plate 14 can reduce frictional resistance caused when the tongue 11a moves. The tongue 11a can thus move preferably.

[0037]

The slip-off portion 13 is formed by cutting one side wall of one end of the arc-shaped groove 12a off in accordance with a form of the tongue 11a. With angular rotation of the motor housing 51, the tongue 11a slips outward from the slip-off portion 13 when the tongue 11a moves to one end of the arc-shaped groove 12a.

[0038]

The lower mounting member 7 has a first mounting portion 71 mounted to a lower end portion of the third shaft housing 33 and a second mounting portion 72 mounted to the car body.

[0039]

The upper mounting member 8 comprises a first mounting portion 82 mounted to the first shaft housing 31, a second mounting portion 83 mounted to the car body, and an impact energy absorber 81 made of synthetic resin for connecting the first mounting portion 82 and the second mounting portion 83.

[0040]

The electric power steering apparatus constituted as above is disposed in a passenger's room and the second mounting portion 72 of the lower mounting member 7 is mounted to the car body with bolts in the same way as the conventional power steering apparatus shown in FIG. 11. The third shaft housing 33 is supported on the car body. The second mounting portion 82 of

the upper mounting member 8 is fixed to the car body with bolts. Moreover, the first shaft housing 31 is mounted to the car body via the upper mounting member 8. In the electric power steering apparatus mounted to the car body, a joint 9 connecting the steering shaft 2 and the steering mechanism is disposed through an instrument panel of the car body.

[0041]

When the instrument panel or the like of the car body is transformed toward the interior of a passenger's room by a frontal crash or the like (a primary crash) of a vehicle, for example, the transformed portion of the instrument panel or the like occasionally strikes against the motor 5. In such a case, since a peripheral face of the motor housing 51 is provided with the upper and lower impact energy receivers 52 and 53, the transformed portion of the instrument panel or the like strikes against a lower impact energy receiver 53 for example, thereby allowing impact energy to be applied to said lower impact energy receiver 53.

[0042]

FIG. 5 is a representation illustrating a state of a motor when support of the motor is released.

Since the lower and upper impact energy receivers 52 and 53 are provided at diagonal positions with regard to a rotational center of the rotor 54, rotational force in a counterclockwise direction of FIG. 4 is applied to the motor housing 51 by impact energy applied to the lower impact energy receiver 53. With rotation of the motor housing 51 caused by this rotational force, the tongue 11a of the motor housing 51 moves in the arc-shaped groove 12a of the shaft housing 3 to the movement permitting portion 12b, and further to the slip-off

portion 13 (see FIG. 5), and slips outward from said slip-off portion 13. Thus, support of the motor 5 on the third shaft housing 33 is automatically released. Consequently, a transformed portion of an instrument panel or the like which has struck against the motor 5 by a primary crash can be further transformed, thereby allowing impact energy of a primary crash to be absorbed preferably.

[0043]

Moreover, when a driver crashes (a secondary crash) into the steering wheel 1 by the action of a shock of the primary crash and impact energy thereof is applied to the first shaft 21 and to the first shaft housing 31 from the first shaft 21 via a ball bearing 26, the first shaft 21 and the first shaft housing 31 are pressured in an axial direction, the impact energy absorber 24 of the steering shaft 2 and the impact energy absorber 81 of the upper mounting member 8 are destroyed, and the first shaft 21 and the first shaft housing 31 move relatively with the second shaft 22 and the second shaft housing 32. Impact energy of the secondary crash can thus be absorbed.

[0044]

When a driver crashes into the steering wheel 1 by the action of a shock of a primary crash as mentioned above, a driver's leg occasionally strikes against the motor 5. In such a case, since a peripheral face of the motor housing 51 is provided with the upper impact energy receiver 52, a driver's leg strikes against the upper impact energy receiver 52 for example, thereby allowing impact energy to be applied to the upper impact energy receiver 52.

[0045]

Since the upper and lower impact energy receivers 52 and 53 are provided at diagonal positions with regard to a rotational center of the rotor 54,

rotational force in a counterclockwise direction of FIG. 4 is applied to the motor housing 51 by impact energy applied to the upper impact energy receiver 52. With rotation of said motor housing 51 caused by this rotational force, the tongue 11a of the motor housing 51 moves in the arc-shaped groove 12a of the shaft housing 3 to the movement permitting portion 12b, and further to the slip-off portion 13 (see FIG. 5), and slips outward from said slip-off portion 13. Support of the motor 5 on the third shaft housing 33 is thus automatically released. Consequently, driver's damage caused by a second crash can be reduced.

[0046]

Within the arc-shaped groove 12a a contact plate 14 is provided to reduce frictional resistance caused when the tongue 11a moves along the movement permitting portion 12b. Consequently, the motor housing 51 provided with the tongue 11a can be angularly rotated preferably. Further, since the contact plate 14 in the arc-shaped groove 12a is pushed against one face of the tongue 11a by the elastic body 15, the tongue 11a is prevented from trembling in the arc-shaped groove 12a.

[0047]

Though a coiled spring is used as an elastic body 15 in releasing means in the above-described embodiment, synthetic rubber or a leaf spring may be employed instead of a coiled spring. When a leaf spring is used, an apparatus without the contact plate 14 may be constituted by disposing the leaf spring at a slant with regard to one side of the arc-shaped groove 12a, for example, so that the leaf spring contacts with one face of the tongue 11a.

[0048]

Embodiment 2

FIG. 6 is a partly sectional front view of a motor portion showing a constitution of Embodiment 2 of an electric power steering apparatus according to the present invention; FIG. 7 is a sectional view taken along the line VII-VII of FIG. 6; FIG. 8 is a sectional view taken along the line VIII-VIII of FIG. 6, in which an interior portion of the motor is omitted; and FIG. 9 is a presentation illustrating a state of a motor when support of the motor is released.

[0049]

In the electric power steering apparatus of Embodiment 2, the projection 11 for supporting the motor 5 on the shaft housing 3 is configured as an external thread 11b and the recess 12 is configured as a through bore 12c into which the external thread 11b is inserted.

[0050]

In Embodiment 2, two threaded holes 61 are provided at the ring-shaped motor supporting portion 34, which is provided at one end side of the second receiver 33b of the third shaft housing 33, with equal phase difference in a peripheral direction. An external thread 11b is screwed into a threaded hole 61.

[0051]

The external thread 11b is configured as a bolt which has a non-thread portion 11e with larger diameter than a thread portion 11c and a slip-off preventing portion 11f with larger diameter than said non-thread portion 11e and the through bore 12c between a thread portion 11c at one end side and a rotation operating portion 11d at the other end side. In a state where the thread portion 11c is screwed into the threaded hole 61, the non-thread portion

11e, the slip-off preventing portion 11f and the rotation operating portion 11d are exposed to the exterior of the motor supporting portion 34.

[0052]

Two mounting tongues 55 are provided at one end portion of the motor housing 51 having the impact energy receivers 52 and 53, more particularly at positions facing the external threads 11b, so as to project in a radial direction. At said mounting tongues 55 the through bores 12c are provided. The non-thread portion 11e of the external thread 11b is inserted into the through bore 12c so as to be movable relatively.

[0053]

One side of the through bore 12c is left open in an arc shape, a center of which is the rotor 54. In said open portion releasing means is constituted which has a movement permitting portion 12d for permitting relative movement of the external thread 11b in the through bore 12c and a slip-off portion 13a from where the external thread 11b slips off said movement permitting portion 12d. It should be noted that, though two pairs of external threads 11b and through bores 12c may be arranged at regular intervals, more than two pairs may be arranged.

[0054]

In Embodiment 2, when impact energy is applied to the lower impact energy receiver 52 of the motor 5 by a primary crash as mentioned in Embodiment 1, rotational force in a counterclockwise direction of FIG. 7 is applied to the motor housing 51 by said impact energy. With rotation of said motor housing 51 caused by this rotational force, the mounting tongue 55 (the through bore 12c portion) of the motor housing 51 moves away from the

external thread 11b of the motor supporting portion 34, and the through bore 12c moves along the movement permitting portion 12d and slips off the external thread 11b at the position of the slip-off portion 13. Support of the motor 5 on the third shaft housing 33 is thus automatically released. Consequently, a transformed portion of an instrument panel or the like which has struck against the motor 5 by a primary crash can be further transformed, thereby allowing impact energy of the primary crash to be absorbed preferably.

[0055]

Moreover, when impact energy is applied to the upper impact energy receiver 52 of the motor 5 by a secondary crash as mentioned in Embodiment 1, rotational force in a clockwise direction of FIG. 7 is applied to the motor housing 51 by said impact energy. With rotation of said motor housing 51 caused by this rotational force, the mounting tongue 55 (the through bore 12c portion) of the motor housing 51 moves away from the external thread 11b of the motor supporting portion 34, and the through bore 12c moves along the movement permitting portion 12d and slips off the external thread 11b at the position of the slip-off portion 13. Support of the motor 5 on the third shaft housing 33 is thus automatically released. Consequently, driver's damage caused by a secondary crash can be reduced.

[0056]

In Embodiment 2, since other structures and functions are the same as those of Embodiment 1, like codes are used to refer to like parts and detailed explanation thereof are omitted.

[0057]

In the above-described embodiment, the impact energy receivers 52

and 53 are provided at diagonal positions with regard to a rotational center of the rotor 54 on faces which are supposed to be upper and lower faces of the motor housing 51 of the motor 5 when the electric power steering apparatus is mounted to the car body. However, one impact energy receiver 52 or 53 may be provided at one of the upper and lower faces of the motor housing 51 of the motor 5 at said position. Moreover, impact energy receivers 52 and 53 may be provided at both sides with regard to the rotational center of the rotor 54 on an upper face and/or a lower face of the motor housing 51 of the motor 5 at said position.

[0058]

[Effect of the Invention]

As described above in detail, with the first invention wherein a supporting unit for supporting a steering assist motor on a stationary member has releasing means for releasing the support by impact energy applied to the motor, when impact energy of a primary crash and/or a secondary crash is applied to the motor, support of the motor on the stationary member can be automatically released, impact energy of a primary crash can be absorbed preferably, and driver's damage caused by a secondary crash can be reduced.

[0059]

With the second invention, the motor can be supported on the stationary member by inserting the projection into the recess. Moreover, the projection relatively moves in the recess at the time of a primary crash and/or a secondary crash, so that support of the motor on the stationary member can be released preferably.

[0060]

With the third invention, when the projection provided at the motor or at the stationary member moves from the recess along the movement permitting portion to the position of the slip-off portion, the elastic body pushes the projection or the recess portion outward, thus releasing support of the motor on the stationary member nimbly.

[0061]

With the fourth invention wherein an existing motor supporting structure having fastening members can be utilized, costs can be relatively reduced.

[0062]

With the fifth invention, impact energy of a primary crash and/or a secondary crash can be suitably applied to the impact energy receiver and the motor housing can be rotated preferably, so that support of the motor on the stationary member can be released more preferably.

[0063]

With the sixth invention, the motor can be supported on the shaft housing by inserting the projection of the motor housing into the arc-shaped groove of the shaft housing. Moreover, the projection can move in the arc-shaped groove at the time of a primary crash and/or a secondary crash, thereby releasing support of the motor on the shaft housing preferably.

[Brief Description of the Drawings]

[FIG. 1]

A front view showing a constitution of an electric power steering apparatus according to the present invention

[FIG. 2]

A sectional view showing a constitution of an electric power steering apparatus according to the present invention

[FIG. 3]

A partly sectional plan view of a motor portion of an electric power steering apparatus according to the present invention

[FIG. 4]

A sectional view taken along the line IV-IV of FIG. 3

[FIG. 5]

A representation illustrating a state of a motor of an electric power steering apparatus according to the present invention when support of the motor is released

[FIG. 6]

A partly sectional front view of a motor portion showing a constitution of Embodiment 2 of an electric power steering apparatus according to the present invention

[FIG. 7]

A sectional view taken along the line VII-VII of FIG. 6

[FIG. 8]

A sectional view taken along the line VIII-VIII of FIG. 6, in which an interior portion of the motor is omitted

[FIG. 9]

A presentation illustrating a state of a motor of Embodiment 2 of an electric power steering apparatus according to the present invention when support of the motor is released

[FIG. 10]

A front view showing a constitution of a conventional electric power steering apparatus

[FIG. 11]

A schematic representation showing a state of a conventional electric power steering apparatus mounted to a car body

[Description of the Reference Numerals]

1 Steering Wheel (Steering Means)

2 Steering Shaft

3 Shaft Housing

5 Motor

51 Motor Housing

52, 53 Impact Energy Receiver

54 Rotor

6 Supporting Unit

11 Projection

11b External Thread

12 Recess

12a Arc-shaped Groove

12b, 12d Movement Permitting Portion (Releasing Means)

12c Through Bore

13, 13a Slip-off Portion (Releasing Means)

15 Elastic Body

[Name of the Document] Abstract of the Disclosure

[Abstract]

[Object] To absorb impact energy of a primary crash preferably and to reduce driver's damage caused by a secondary crash.

[Means for Achieving the Object] A supporting unit 6 for supporting a steering assist motor 5 on a stationary member comprises a projection 11 provided at one end of a motor housing 51; a recess 12 provided at the stationary member, into which said projection 11 is inserted; a movement permitting portion 12b for permitting relative movement of the projection 11 in the recess 12; and a slip-off portion 13 from where the projection 11 slips off said movement permitting portion 12b. When impact energy of a primary crash and/or a secondary crash is applied to the motor housing 51, support of the motor 5 on the stationary member can be automatically released by rotating said motor housing 51.

[Drawing to Be Selected] FIG. 4

FIG. 1

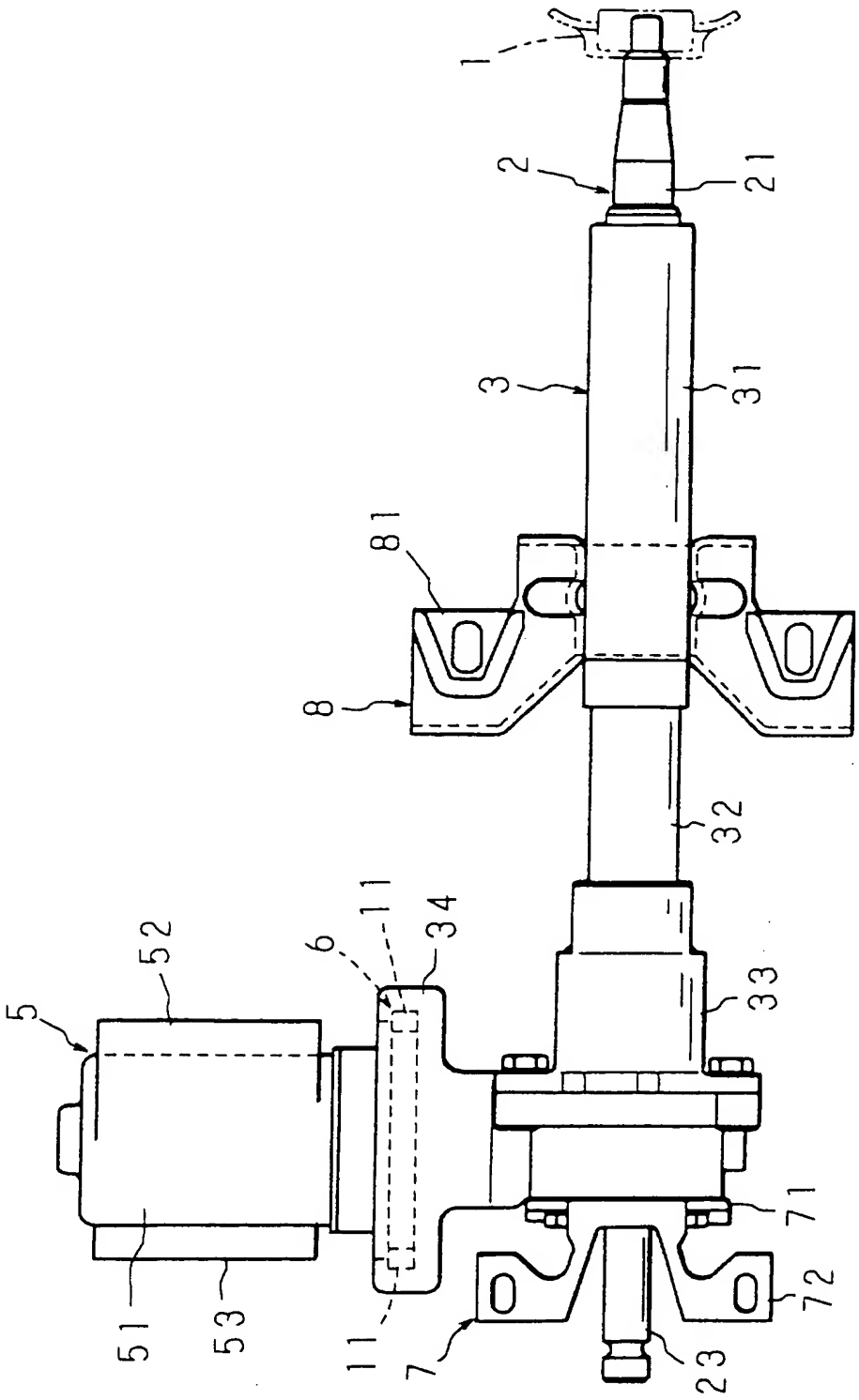

FIG. 2

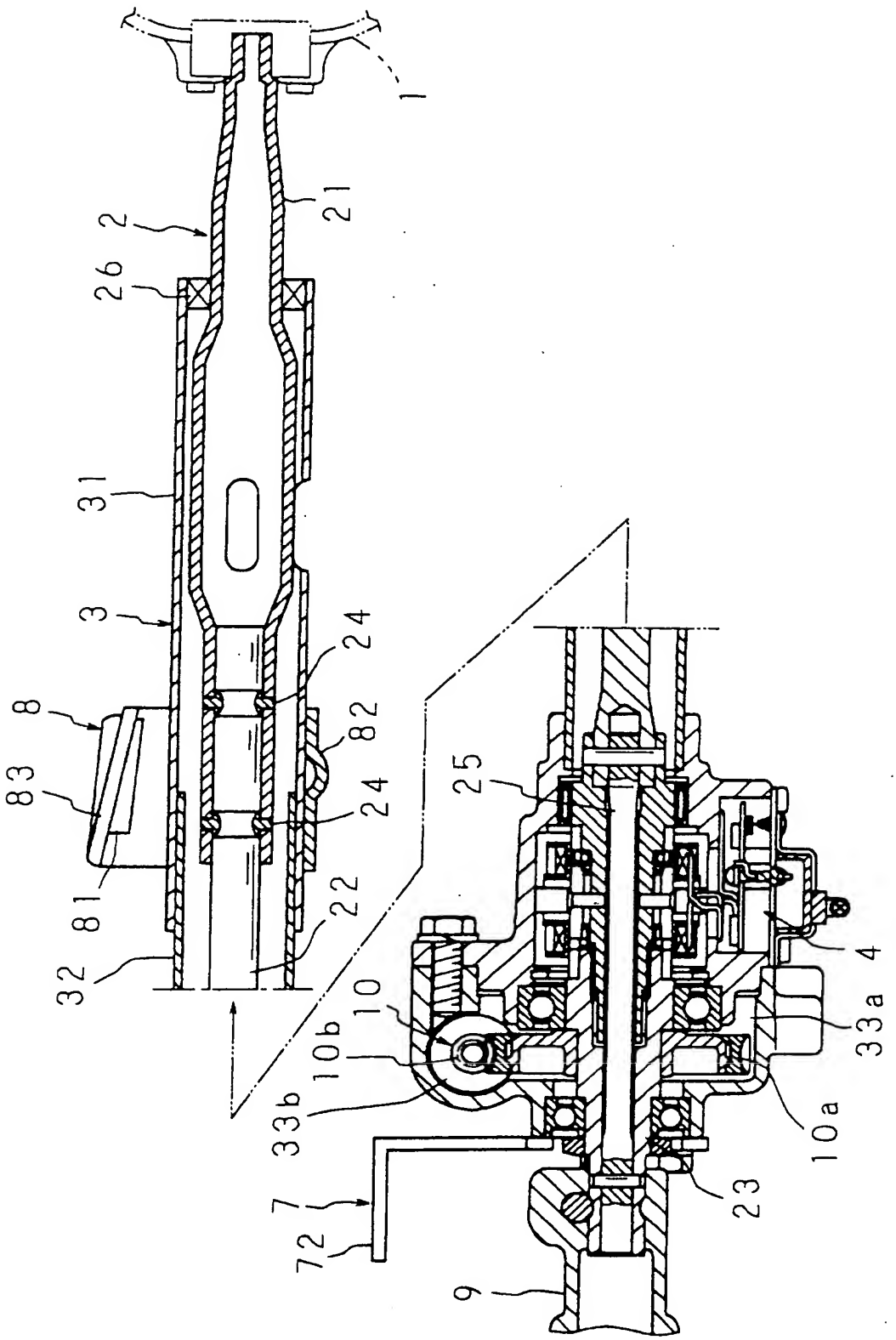

FIG. 3

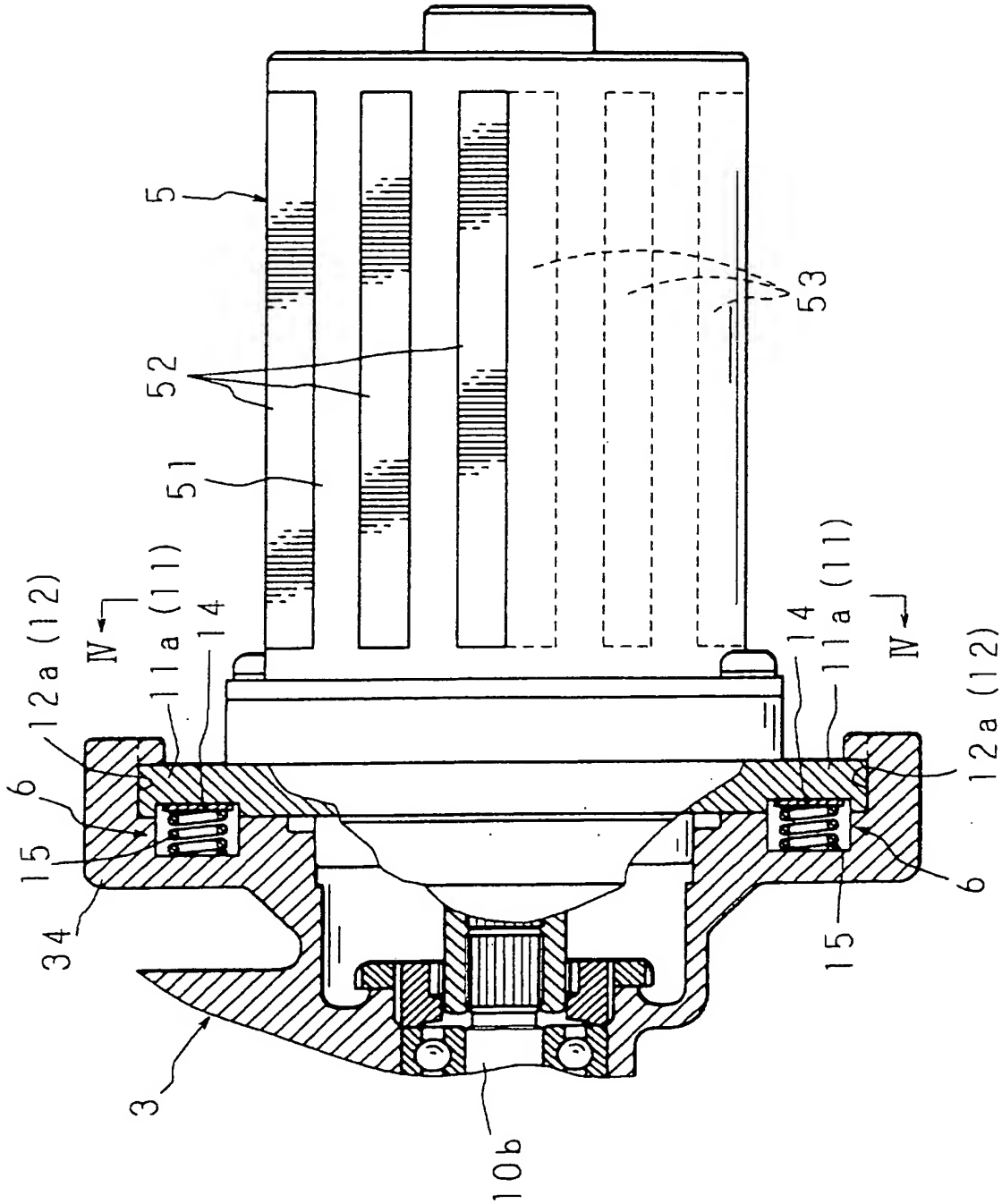

FIG. 4

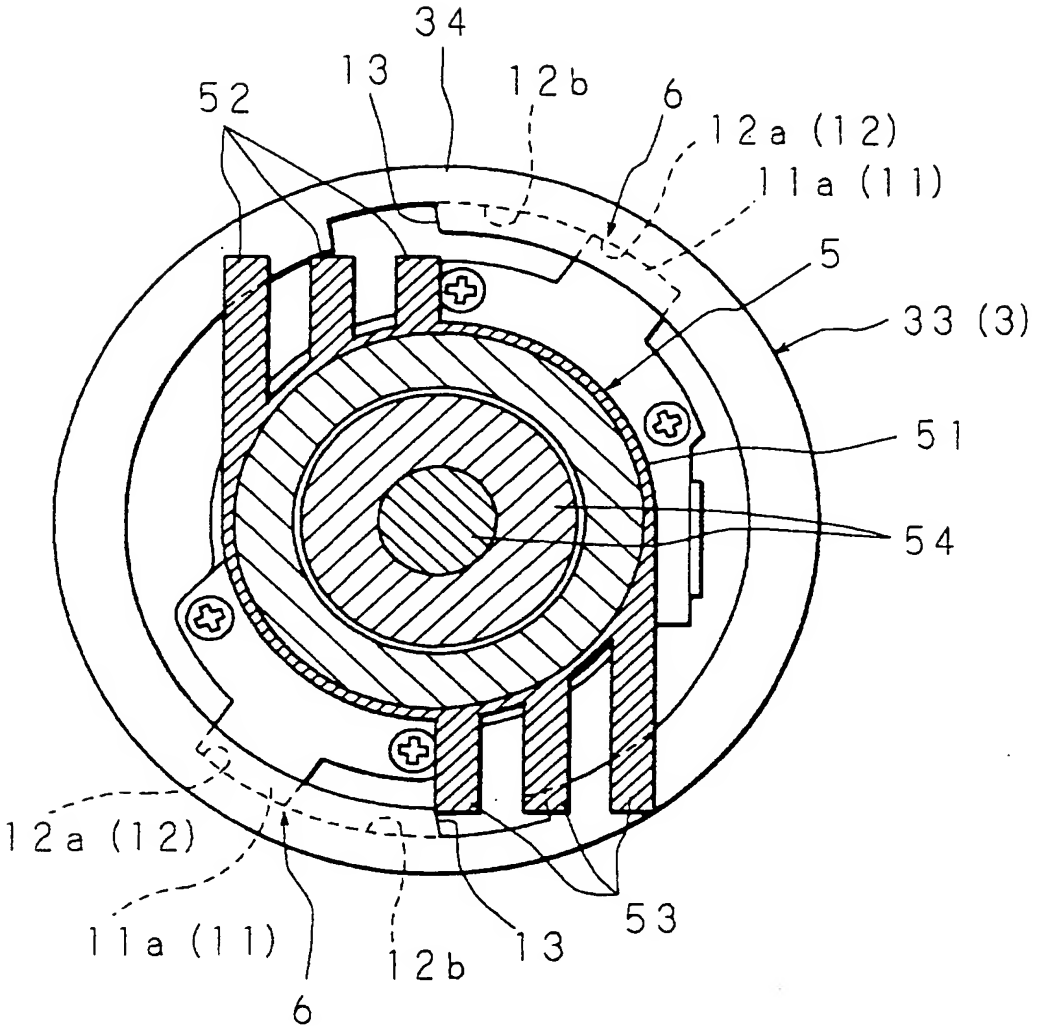

FIG. 5

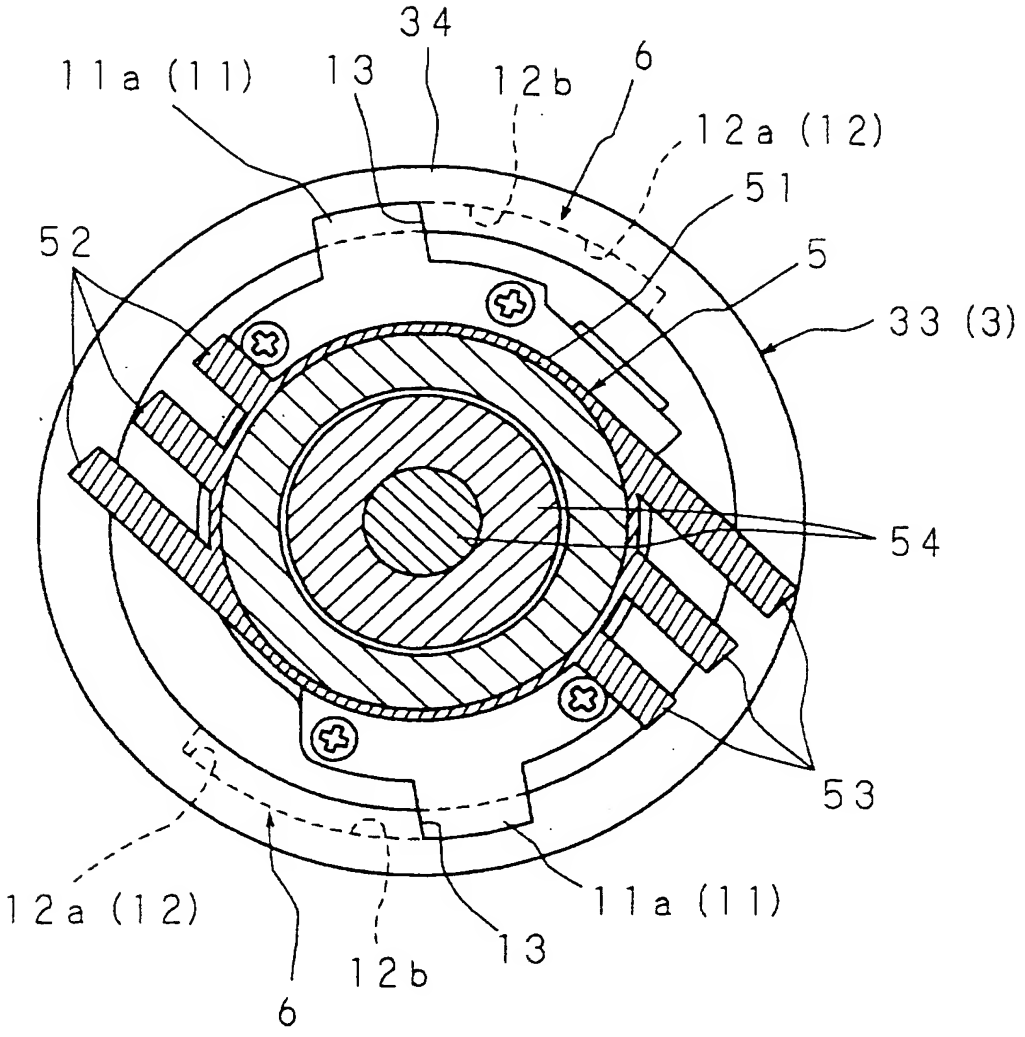

FIG. 6

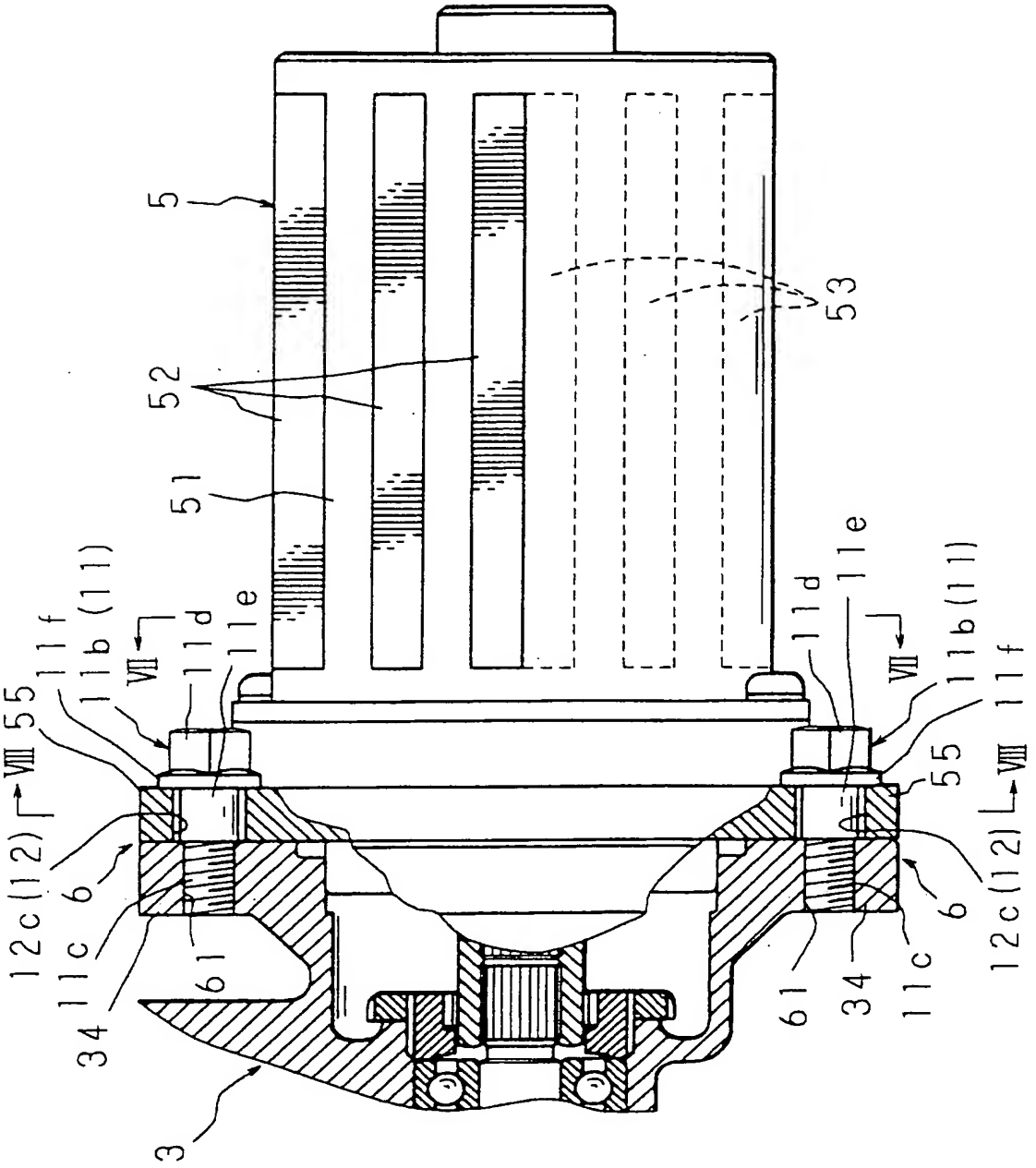

FIG. 7

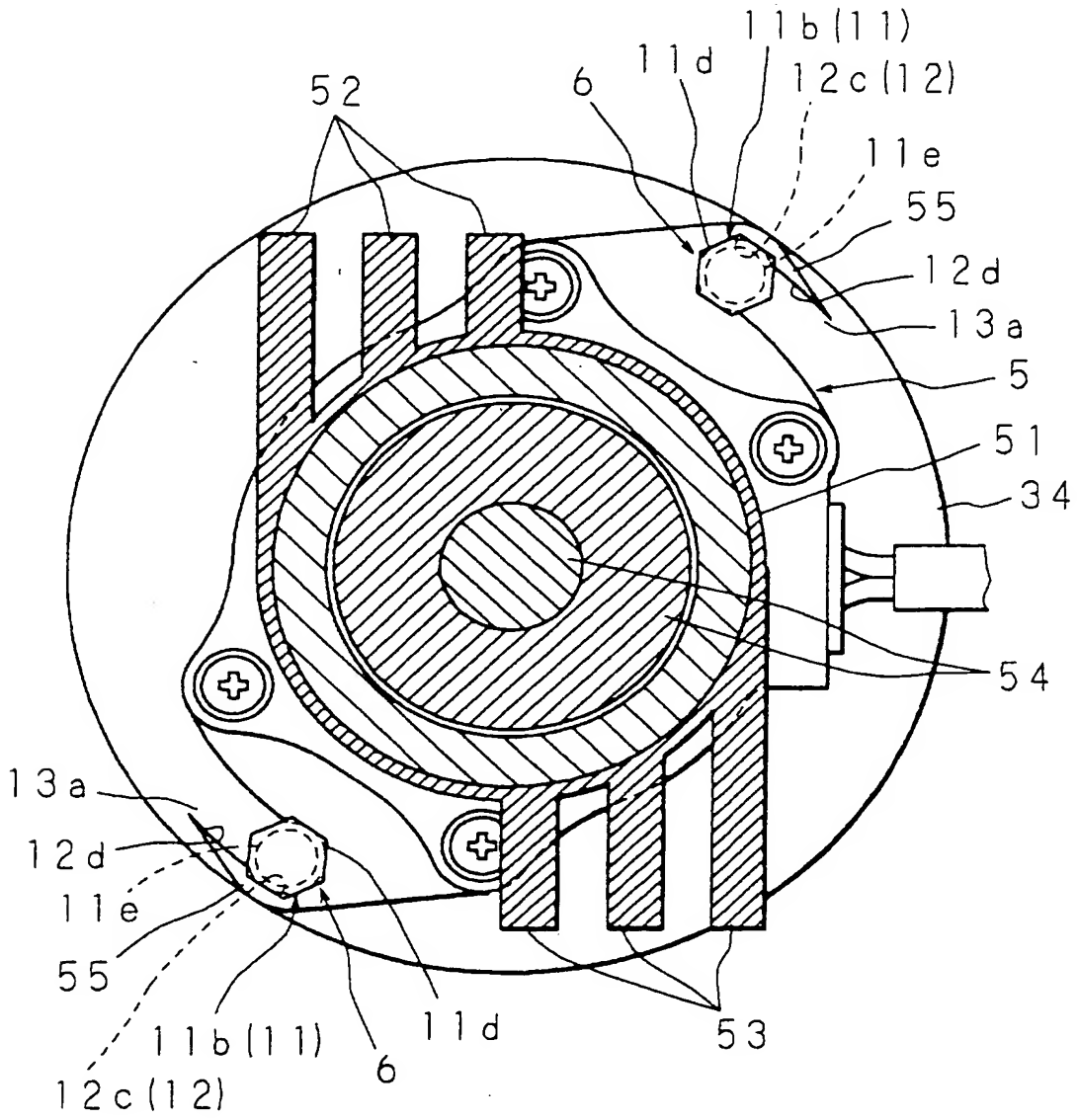
52
6
11d
11b(11)
12c(12)
11e
55
12d
13a
5
51
34
54
13a
12d
11e
55
11b(11)
6
11d
53
12c(12)

FIG. 8

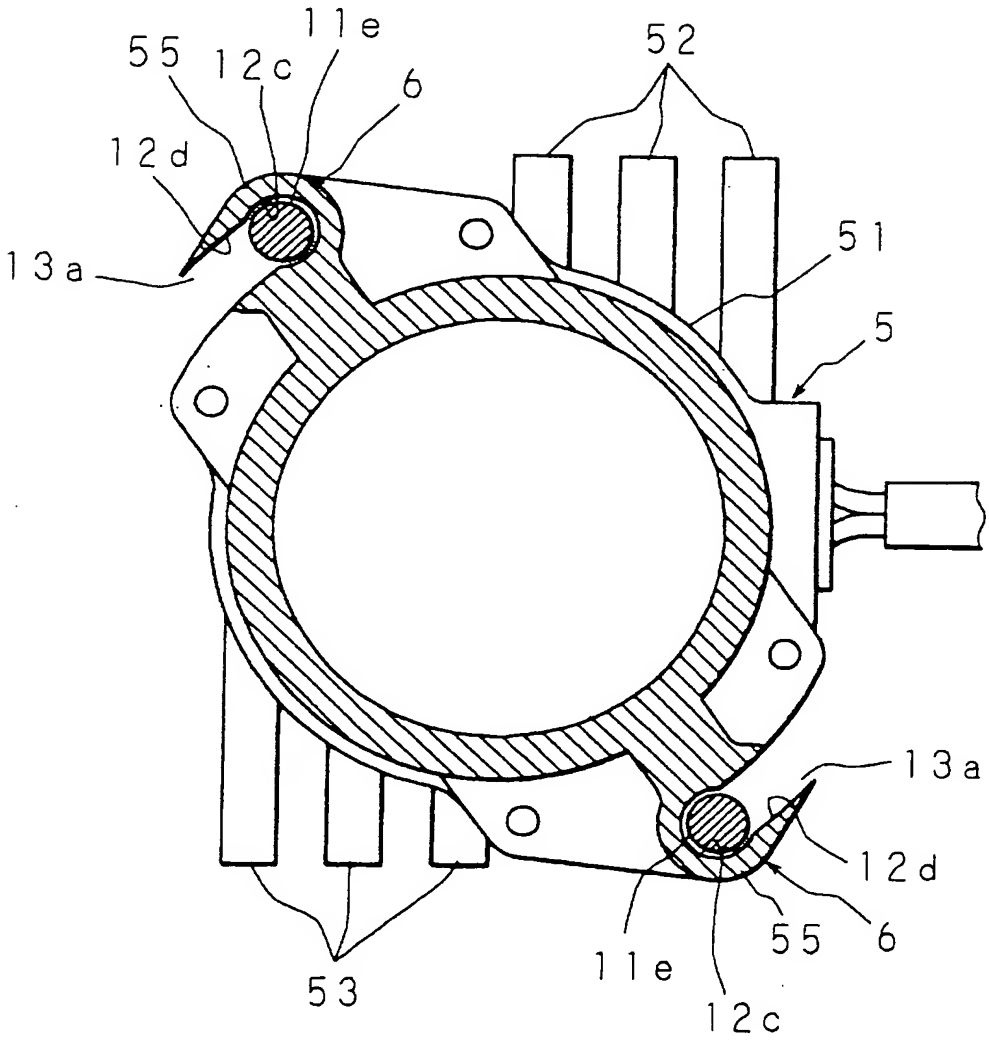

FIG. 9

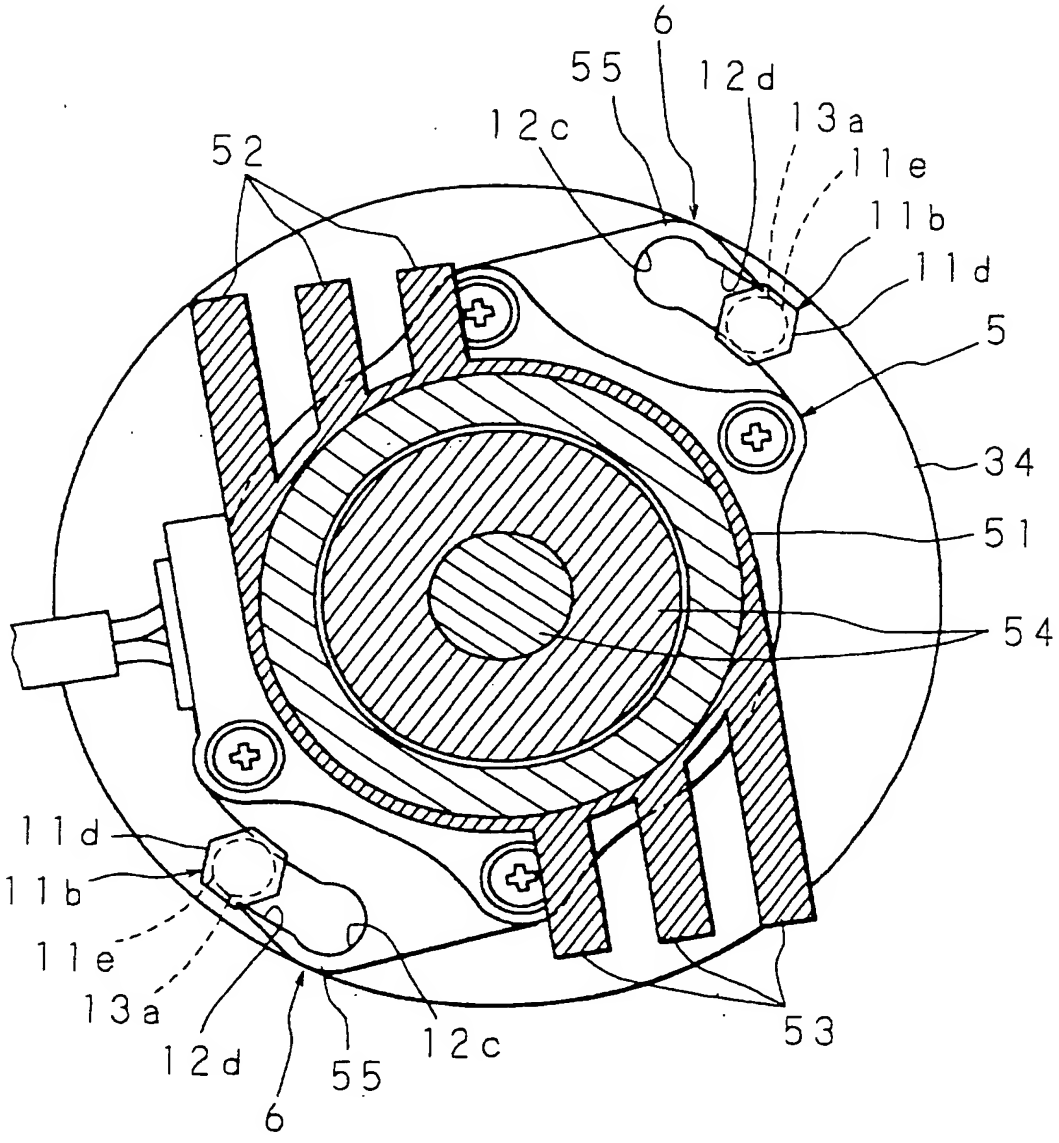
6
55
12d
13a
12c
11e
52
11b
11d
5
34
51
54
11d
11b
11e
13a
12d
55
6
12c
53

FIG. 10

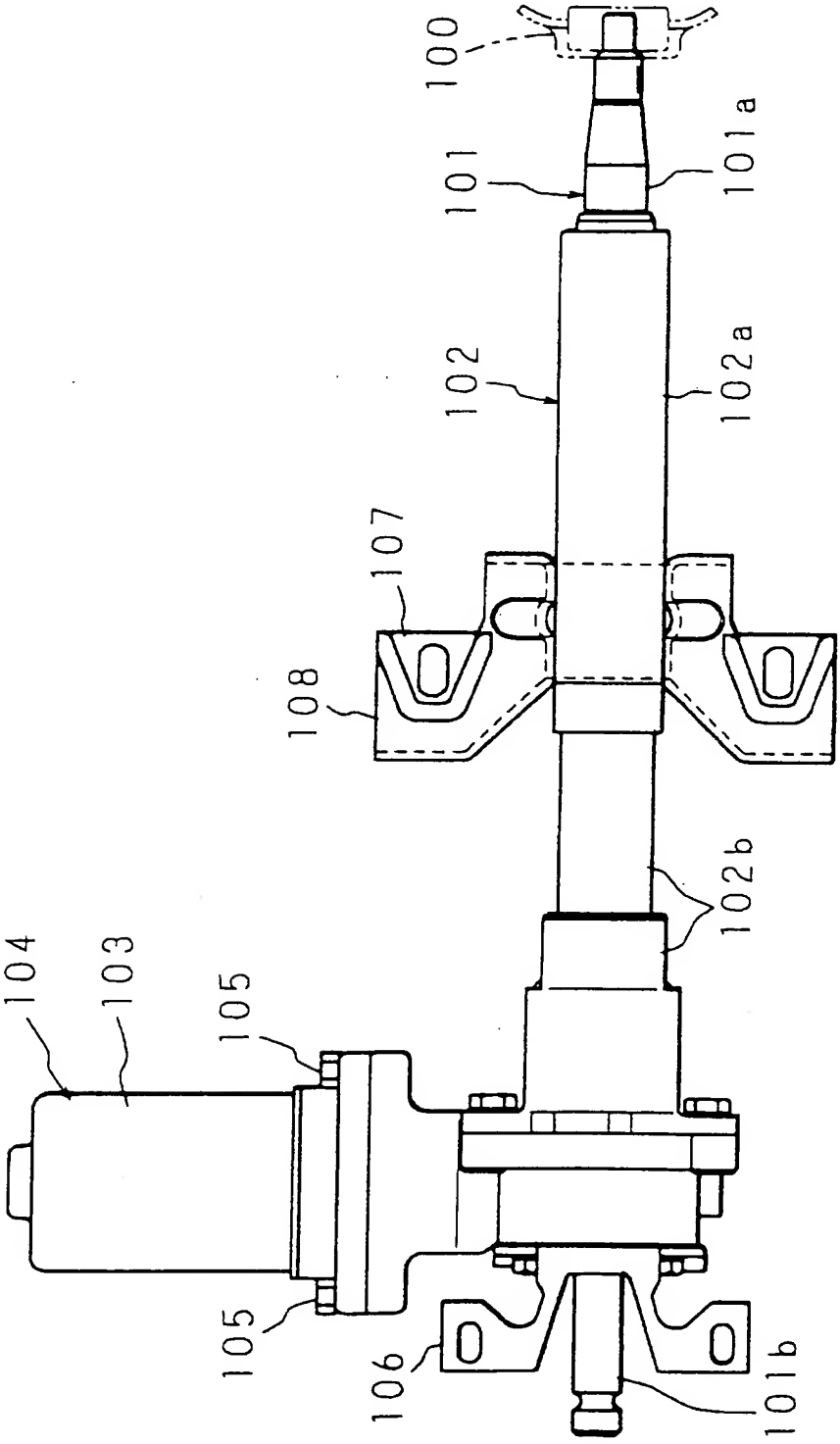

FIG. 11